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Global risk and the dollar[☆]

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ABSTRACT

The dollar is a safe-haven currency and appreciates when global risk goes up. We investigate the dollar's role for the transmission of global risk to the world economy within a Bayesian proxy structural vector autoregressive model. We identify global risk shocks using high-frequency asset-price surprises around narratively selected events. Global risk shocks appreciate the dollar, induce tighter global financial conditions and a synchronized contraction of world economic activity. We benchmark these effects against counterfactuals in which the dollar does not appreciate. In the absence of dollar appreciation, the contractionary impact of a global risk shock is much weaker, both in the rest of the world and the US. For the rest of the world, contractionary financial channels thus dominate expansionary expenditure switching when global risk rises and the dollar appreciates.

1. Introduction

According to the received wisdom the dollar appreciates when global risk goes up. Fig. 1 presents the Global Financial Crisis (GFC) and the COVID-19 pandemic as striking examples. This co-movement is a general pattern of the data and testifies to a fundamental asymmetry in a global financial system centered around the dollar.[1] While the dollar's prominence can be rationalized on the ground that some assets are particularly safe or liquid (Farhi and Gabaix, 2016; He et al., 2019; Gopinath and Stein, 2021; Chahrour and Valchev, 2022; Eren and Malamud, 2022), the role of its appreciation in the transmission of global risk is unclear: Does it help the world economy in coping with global risk shocks or does it amplify their adverse impact?

We shed light on this question by exploring the net effect of dollar appreciation in the transmission of global risk. We first upgrade the received wisdom to rigorous causal evidence using a state-of-the-art structural vector-autoregressive (VAR) model identified using narrative external instruments. We show that exogenous global risk shocks induce an appreciation of the dollar. They furthermore contract economic activity in the US and the rest of the world (RoW). Reflecting a trade channel, US net exports fall, suggesting that dollar appreciation induces expenditure switching in the RoW (Gopinath et al., 2020). Reflecting a financial

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[1] In a regression of changes in the VIX on changes in the dollar exchange rate over the period 01/1990-12/2020 the *t*-value is 5.8, and 2.2 when excluding the period 7/2008-12/2009 and after 03/2020. Consistent with the findings in Lilley et al. (2022), the *t*-value is essentially zero for the time period prior to the GFC, it is 4.3 for the post-GFC period 1/2010-12/2020, and 3.6 for the inter-crises period 1/2010-3/2020.

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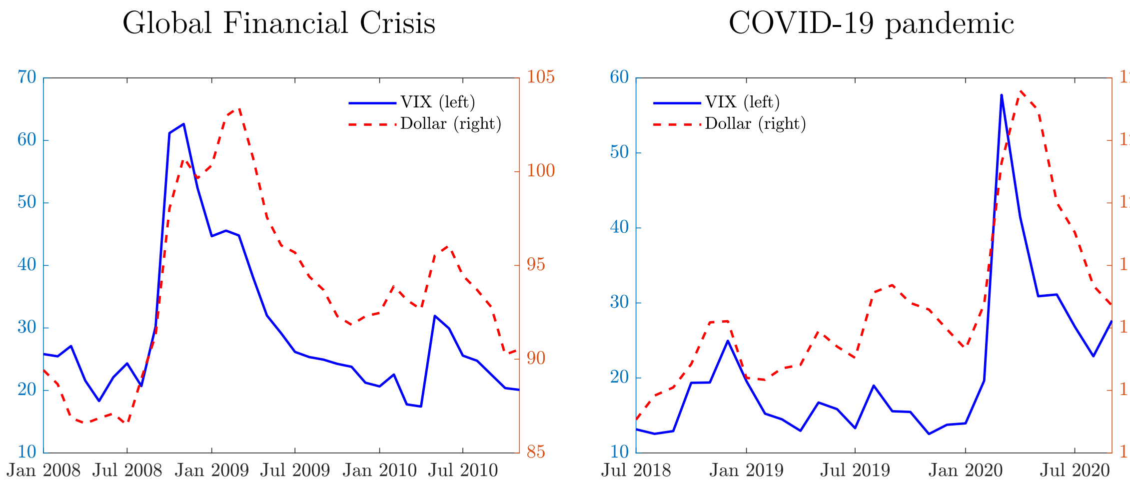

Fig. 1. The US dollar and the VIX.
Note: VIX is an index of expected stock market volatility compiled by Chicago Board of Options Exchange; dollar is the price of dollar expressed in foreign currency (in effective terms) such that an increase represents an appreciation.

channel, global equity prices drop, spreads increase and cross-border bank credit contracts (Bruno and Shin, 2015; Jiang et al., 2024; Kekre and Lenel, 2021).

Second, we construct three conceptually distinct counterfactuals that simulate the effects of a global risk shock in the *absence* of dollar appreciation. The first counterfactual is based on the estimated VAR model and explores the most likely path of the endogenous variables conditional on a global risk shock in a scenario in which the dollar happens to not appreciate because additional, offsetting shocks materialize as well (Antolin-Diaz et al., 2021). The second counterfactual is a VAR-based policy-rule experiment in which the Federal Reserve (Fed) stabilizes the dollar exchange rate conditional on a global risk shock (McKay and Wolf, 2023). The third counterfactual is based on a structural model for the US and the RoW in which the deep parameters can be modified so that the dollar does not have a dominant status in cross-border credit and safe assets, which is responsible for the appreciation upon a global risk shock in the first place.

We find that while in all no-appreciation counterfactuals a global risk shock still causes a slowdown in US and RoW activity, the contraction is substantially reduced relative to the baseline by about – depending on the horizon and the methodology – 30%–50%. Without dollar appreciation the response of US net exports hardly changes. Expenditure switching thus contributes little to the transmission of a global risk shock to the rest of the world through dollar appreciation. While financial conditions still move in the absence of dollar appreciation, they tighten by much less. The financial channel thus plays a key role in the transmission of a global risk shock through dollar appreciation. Put differently, the contractionary effects that materialize through tighter financial conditions dominate expansionary effects through expenditure switching.

In more detail, we estimate a Bayesian proxy structural VAR (BPSVAR) model using the approach of Arias et al. (2021). Specifically, we extend the closed-economy VAR model of Gertler and Karadi (2015) which features US industrial production, the 1-Treasury bill rate, the excess bond premium, and consumer prices and include the dollar nominal effective exchange rate, the 5-Treasury bill rate, the VXO, RoW industrial production and policy rates.

In order to identify a global risk shock we rely on an external instrument (Mertens and Ravn, 2013). As in Piffer and Podstawski (2018) we use gold-price changes in narrow intra-daily windows around the time stamps of global risk events selected narratively originally by Bloom (2009). We estimate the model on monthly data for the period 1990–2019. In order to speak to the theoretical literature on the dominant role of the dollar, we consider extended specifications with US exports and imports, cross-border bank credit to non-US borrowers, the Emerging Markets Bond Index (EMBI) spread, and RoW equity prices.

We find that a global risk shock appreciates the dollar and contracts US and RoW industrial production. US and RoW monetary policy loosen. Consistent with a trade channel, US net exports fall. Consistent with a financial channel, cross-border credit contracts, RoW equity prices fall and the EMBI spread rises.

We then construct no-appreciation counterfactuals to assess the dollar's contribution to the transmission of a global risk shock to the RoW. The first counterfactual is implemented in the BPSVAR model based on the idea that the dollar does not appreciate because a series of additional, offsetting shocks materialize (Antolin-Diaz et al., 2021). Specifically, we cast impulse responses into a forecast conditioned on a global risk shock occurring in period t and subject to the constraint that the dollar does not appreciate along the forecast horizon $t, t+1, \ldots, t+H$. The offsetting shocks that materialize along the forecast horizon and enforce the no-appreciation constraint are chosen so as to be as small as possible and least correlated, hence deviating minimally from the baseline of a standard global risk shock impulse response. Intuitively, this counterfactual can be thought of as the most likely scenario in which the dollar does not appreciate following a global risk shock and which could be observed in practice.

The second counterfactual assumes the Fed deviates from its actual policy rule and stabilizes the dollar exchange rate. McKay and Wolf (2023) show that even without knowing the true structural model a policy-rule counterfactual can be recovered in a

VAR model using a set of period-t policy shocks. To implement this counterfactual, we additionally identify conventional Fed funds rate and forward guidance shocks. Following McKay and Wolf (2023) we then choose the size of these shocks so that when they materialize together with a global risk shock in period t the dollar stays at its baseline value over horizons $t, t+1, \dots, t+H$.

The third counterfactual is based on a structural model for the US and the RoW in which the dollar appreciates upon a global risk shock because of the interplay between dollar dominance in safe assets and cross-border finance (Georgiadis et al., 2023). In the model, when global risk aversion goes up and the world economy contracts, holding US Treasuries increasingly loosens balance-sheet constraints of RoW banks indebted in foreign currency, which causes the Treasury convenience yield to rise and the dollar to appreciate. To implement a counterfactual in which the dollar does not appreciate upon a global risk shock, we shut down dollar dominance in cross-border finance and safe assets. Intuitively, this can be thought of as showing how a global risk shock would play out in a counterfactual world in which the dollar does not appreciate for structural reasons other than variation in the policy rule.

In all counterfactuals the contractionary effect of a global risk shock still causes a slowdown in US and RoW activity, but the contraction is substantially reduced relative to the baseline by about 30%–50%. This implies that in the baseline the contractionary effects that operate via the financial channel dominate the expansionary effects that operate via the trade channel.

Related literature. Our empirical analysis speaks to theoretical work on the special role of the dollar and US assets in the international monetary system (Gopinath et al., 2020; Jiang et al., 2024; Kekre and Lenel, 2021; Bianchi et al., 2021; Devereux et al., 2022). Our analysis assesses the empirical relevance of the mechanisms spelled out in this work. More generally, our analysis informs the theoretical literature on the role of exchange rates for the cross-border transmission of shocks through financial channels (Banerjee et al., 2016; Aoki et al., 2018; Akinci and Queralto, 2019; Croce et al., 2022).

Our paper is also related to empirical work that studies the role of the dollar as a global risk factor (Lustig et al., 2014; Verdelhan, 2018), the predictive power of convenience yields (Engel and Wu, 2018; Valchev, 2020; Jiang et al., 2021) and global risk (Lilley et al., 2022; Hassan et al., 2024) for the dollar, as well as the relationship between global risk, deviations from covered interest parity, the dollar and cross-border credit (Avdjiev et al., 2019; Erik et al., 2020). We complement this work by moving from forecasting and reduced-form regressions to isolating the effects of exogenous variation in global risk.

Our paper furthermore contributes to empirical work on the role of financial channels in the global transmission of risk shocks (Liu et al., 2017; Cesa-Bianchi et al., 2018; Epstein et al., 2019; Shousha, 2019; Bhattarai et al., 2020). Relative to existing work, we zoom in on and quantify the role of the dollar within the broader class of financial channels. Our findings on the role of the dollar for financial spillovers complement existing evidence from micro data (Shim et al., 2021; Bruno and Shin, 2023; Niepmann and Schmidt-Eisenlohr, 2022). Relative to this work, our analysis allows us to contrast trade and financial channels and hence assess the net effect of dollar appreciation.

Finally, our paper is related to the literature on shock identification using external instruments in VAR models (Mertens and Ravn, 2013; Gertler and Karadi, 2015; Caldara and Herbst, 2019). In contrast to much of the existing work we employ the Bayesian estimation approach of Arias et al. (2021) to jointly identify several structural shocks by means of multiple external instruments and use exact finite sample inference in order to bypass questions about the appropriate asymptotic inference in the presence of multiple and potentially weak instruments (Jentsch and Lunsford, 2019; Montiel Olea et al., 2021). Moreover, we postulate only relatively weak additional exogeneity assumptions in order to avoid set-identification and difficulties in posterior inference (Baumeister and Hamilton, 2015; Giacomini and Kitagawa, 2021).

The rest of the paper is structured as follows. Section 2 lays out the BPSVAR framework and describes our empirical specification. Section 3 presents results for the effects of global risk shocks in the data. Section 4 explores no-appreciation counterfactuals. Section 5 concludes.

2. Empirical strategy

We first outline the BPSVAR framework of Arias et al. (2021) and discuss our specification and identification assumptions. We keep the discussion short and refer to the working paper version of this paper for details (Georgiadis et al., 2021).

2.1. The BPSVAR framework

Consider the structural VAR model

$$\boldsymbol{y}_t' \boldsymbol{A}_0 = \boldsymbol{y}_{t-1}' \boldsymbol{A}_1 + \boldsymbol{\epsilon}_t', \tag{1}$$

where $\boldsymbol{y}_t$ is an $n \times 1$ vector of endogenous variables and $\boldsymbol{\epsilon}_t$ an $n \times 1$ vector of structural shocks. Assume there is a $k \times 1$ vector of observed proxy variables – or, in alternative jargon, external instruments – $\boldsymbol{p}_t$ that are correlated with the k unobserved structural shocks of interest $\boldsymbol{\epsilon}_t^*$ (relevance condition) and orthogonal to the remaining unobserved structural shocks $\boldsymbol{\epsilon}_t^o$ (exogeneity condition):

$$E[\boldsymbol{p}_t \boldsymbol{\epsilon}_t^{*\prime}] = \boldsymbol{V}, \qquad E[\boldsymbol{p}_t \boldsymbol{\epsilon}_t^{o\prime}] = \boldsymbol{0}. \tag{2}$$

Arias et al. (2021) develop a Bayesian algorithm that imposes these assumptions in the estimation of the VAR model in Eq. (1) augmented with equations for the proxy variables. The estimation thereby identifies the structural shocks.

2.2. BPSVAR model specification

Our point of departure is the closed-economy US VAR model of Gertler and Karadi (2015), which includes in $\boldsymbol{y}_t$ the logarithms of US industrial production and consumer prices, the excess bond premium of Gilchrist and Zakrajsek (2012), and the 1-year Treasury bill rate as monetary policy indicator. We augment $\boldsymbol{y}_t$ with the VXO, the logarithm of an index of non-US, RoW industrial production, a weighted average of advanced economies' (AEs) policy rates, the 5-year Treasury bill rate, and the logarithm of the US dollar nominal effective exchange rate (NEER).[2] We use monthly data for the time period from February 1990 to December 2019 and flat priors for the VAR parameters. Data descriptions are provided in Table C.1 in the Online Appendix.

2.3. Identification

For ease of exposition, we first only discuss the identification of the global risk shock given it is our key shock of interest. We explain in Section 4.2 how we additionally identify the US monetary policy shocks we use in one of the counterfactuals.

We think of a global risk shock as an incident that is associated with an exogenous drop in investors' risk appetite, which can be understood as a shock to the price – as opposed to the quantity – of risk (Miranda-Agrippino and Rey, 2020b; Bauer et al., 2023).

The proxy variable $p_t^{\epsilon,r}$ for the global risk shock is based on intra-daily data in the spirit of the high-frequency identification of monetary policy shocks (e.g. Gertler and Karadi, 2015). In particular, we use intra-daily changes in the price of gold around the time stamps of narratively selected events originally selected by Bloom (2009) and later updated by Piffer and Podstawski (2018) and Bobasu et al. (2021). We consider the events labeled as 'global' and 'US' by Piffer and Podstawski (2018). We assume global risk shocks drive gold-price surprises on the narratively selected events, that is in the relevance condition in Eq. (2) we have $E[p_t^{\epsilon,r}\epsilon_t^r] \neq 0$. The intuition is that an increase in global risk raises the price of the archetypical safe asset of gold (Baur and McDermott, 2010; Ludvigson et al., 2021).

Regarding the exogeneity condition $E[p_t^{\epsilon,r}\epsilon_t^o] = 0$ in Eq. (2), Piffer and Podstawski (2018) document that the intra-daily gold-price surprises on the narratively selected events are not systematically correlated with a range of measures of non-risk shocks. In other words, we assume the only shock that occurred systematically in the intra-daily windows across the narratively selected events is the global risk shock. Note that what is critical for the exogeneity condition to be satisfied is that across the full list of narratively selected events the gold-price surprises around the intra-daily windows were driven *systematically* only by global risk shocks. For this, the selection of events and the width of the intra-daily windows around the corresponding time stamps rather than the specific asset price are crucial. We explore robustness checks for both aspects below.

Finally, for consistency we follow (Caldara and Herbst, 2019) as well as (Arias et al., 2021) and impose a 'relevance threshold' to express a prior belief that the proxy variables are relevant instruments: We require that at least 10% of the variance of the proxy variables is accounted for by the identified shocks; this is less than the 20% required by Arias et al. (2021), and – although not straightforward to compare conceptually – below the 'high-relevance' prior of Caldara and Herbst (2019). Specifying the relevance threshold at 10% implies there is a lot of room for the proxy variable measurement error in the BPSVAR model to account for events on which global risk shocks occurred but the recorded gold-price surprise is zero as they are not selected by Bloom (2009), Piffer and Podstawski (2018) and Bobasu et al. (2021). We explore robustness checks without relevance threshold below.

3. The effect of global risk shocks on the world economy

Fig. 2 shows our first result: A one-standard deviation global risk shock increases the VXO and appreciates the dollar. This implies the positive co-movement between global risk and the dollar shown in Fig. 1 is at least to some extent accounted for by global risk shocks. US and RoW industrial production both contract, but the effect in the US is more immediate and somewhat larger. US consumer prices fall after a short delay and the excess bond premium rises. US and RoW monetary policy are loosened.

Fig. 3 presents the responses of global financial conditions and US trade. Consistent with a financial channel, cross-border bank credit to non-US borrowers declines, RoW equity prices contract and spreads increase. Consistent with a trade channel through expenditure switching US net exports contract.[3]

In the Online Appendix we present results for several extensions. We document that in response to a global risk shock: also other safe-haven currencies such as the Japanese yen and the Swiss franc appreciate, while non safe-haven currencies such as the euro and the British pound depreciate (Figure B.3); the price of safety in terms of the Treasury premium of Du et al. (2018) increases; consistent with the model of Bianchi et al. (2021) banks raise the ratio of safe and liquid dollar assets to liabilities (Figure B.3); that there is evidence for 'fear-of-floating' as EME monetary policy tightens at the same time as output contracts (Figure B.1); when we additionally impose forecast error variance decomposition restrictions in the spirit of Francis et al. (2014) to disentangle shocks to the price – risk appetite – and the quantity of risk – uncertainty – both shocks appreciate the dollar and exhibit qualitatively similar patterns, but the impulse responses to the global risk appetite shock correspond more closely to those from our baseline (Figure B.4).

[2] We use AE instead of RoW policy rates as the latter exhibit spikes reflecting periods of hyperinflation in some EMEs. In the Online Appendix we consider an extension in which we include AE and EME industrial production, prices and policy rates separately (Figure B.1). Furthermore, we document in the Online Appendix that results are robust to including a measure of RoW prices (Figure B.2).

[3] That the contraction is more immediate in US exports than imports is consistent with dominant-currency paradigm (DCP) in trade invoicing (Gopinath et al., 2020). As under DCP US export prices are sticky in dollar, a dollar appreciation induces immediate expenditure switching in the RoW. In contrast, as also RoW export prices are sticky in dollar, there is no expenditure switching in the US; the response of US imports to a global risk shock is then driven only by the hump-shaped contraction in US demand.

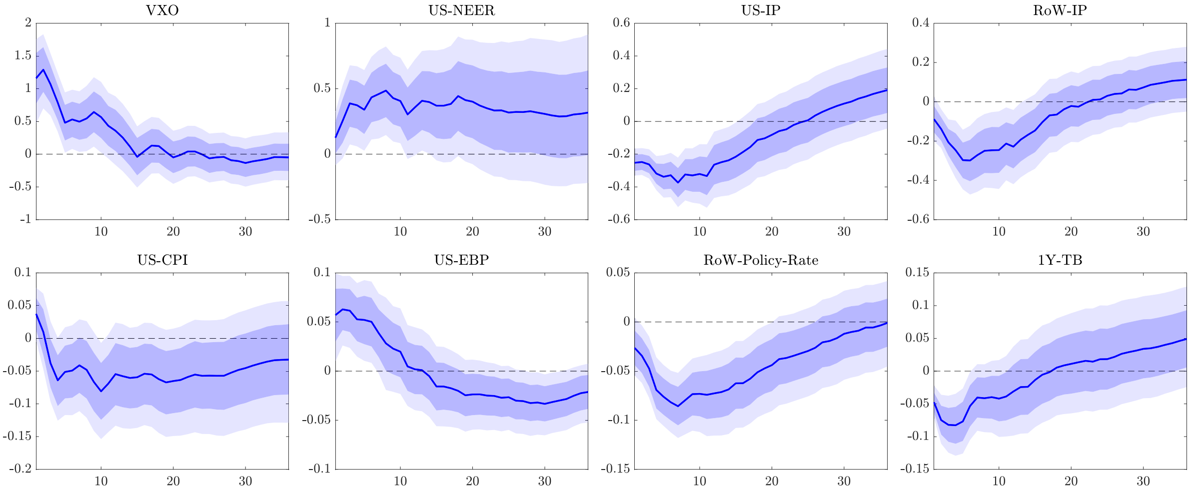

Fig. 2. Impulse responses to a global risk shock.
Note: Horizontal axis measures time in months, vertical axis deviation from pre-shock level; size of shock is one standard deviation; blue solid line represents point-wise posterior mean, light-shaded areas 90% and dark-shaded areas 68% equal-tailed, point-wise credible sets. VXO measured in levels, the dollar NEER, US and RoW industrial production, US consumer prices in logs, and the excess bond premium, the RoW policy as well as the US 1-year Treasury Bill rates in percent.

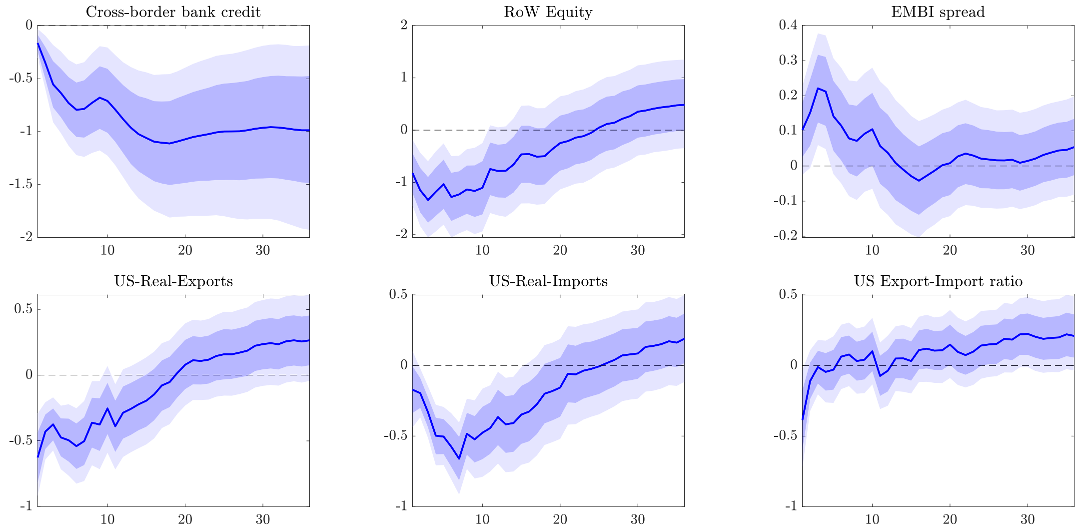

Fig. 3. Impulse responses of trade and financial variables to a global risk shock. Note: See notes to Fig. 2.

In the Online Appendix we also document that the estimated effects of global risk shocks hardly change if: as in Ludvigson et al. (2021) we relax the exogeneity condition and only impose $|E[p_t^{\epsilon,r}\epsilon_t^r]| > |E[p_t^{\epsilon,r}\epsilon_t^\ell]|$ for $\ell \neq r$ (Figure B.5); we address concerns that the gold-price surprises calculated over windows of several hours are contaminated by other shocks occurring close to the narratively selected event time stamps by considering long-term Treasury yield and US dollar/euro exchange rate surprises over narrower windows (Figure B.6 and B.7); we abandon the narratively selected events and instead consider monthly changes in the Geopolitical Risk Index of Caldara and Iacoviello (2022) as proxy variable (Figure B.8); we estimate a larger BPSVAR model with many more US and RoW variables (Figure B.9); we do not impose a relevance threshold (Figure B.10).

4. The role of the dollar

Our results suggest the dollar appreciation caused by a global risk shock impacts the RoW through both a trade and a financial channel. Given that the trade channel and financial channel impact RoW real activity with opposite signs, the net effect of dollar appreciation upon a global risk shock is ambiguous. In this section we determine the net effect by benchmarking the baseline impulse responses against a counterfactual in which the dollar does not appreciate. To robustify our analysis, we consider three conceptually distinct no-appreciation counterfactuals.

4.1. A possible empirical scenario

The first approach is based on structural scenario analysis (SSA; Antolin-Diaz et al., 2021, ADPRR). ADPRR develop SSA as a flexible framework for conditional forecasts. We apply SSA to construct a no-appreciation counterfactual. In particular, we first represent the impulse responses as conditional forecasts for a system that is in its steady state in period $t-1$ and then hit by a single global risk shock in period t. Then we determine the smallest and least correlated shocks that would have to materialize in periods $t, t+1, \dots, t+h$ in order to offset the effect of the period-t global risk shock on the dollar. Intuitively, this counterfactual can be thought of as the most likely scenario in which the dollar does not appreciate upon a global risk shock and which could be observed in practice.

Formally, assume for simplicity but without loss of generality that the VAR model in Eq. (1) is stationary and that it does not include deterministic terms. After iterating forward from period t to $t+h$ we have

$$\boldsymbol{y}_{t,t+h} = \boldsymbol{b}_{t,t+h} + \boldsymbol{M}'\boldsymbol{\epsilon}_{t,t+h}, \tag{3}$$

where the $n(h+1)\times 1$-vectors $\boldsymbol{y}_{t,t+h} \equiv (\boldsymbol{y}_t', \boldsymbol{y}_{t+1}', \dots, \boldsymbol{y}_{t+h}')'$ and $\boldsymbol{\epsilon}_{t,t+h} \equiv (\boldsymbol{\epsilon}_t', \boldsymbol{\epsilon}_{t+1}', \dots, \boldsymbol{\epsilon}_{t+h}')'$ stack the endogenous variables and structural shocks for periods $t, t+1, \dots, t+h$, respectively, the $n(h+1)\times n(h+1)$ matrix $\boldsymbol{M} = \boldsymbol{M}(\boldsymbol{A}_0, \boldsymbol{A}_1)$ represents the effects of these structural shocks in terms of impulse responses, and $\boldsymbol{b}_{t,t+h}$ period-$(t-1)$ initial conditions. Assume further the VAR model is in steady state in period $t-1$ so that $\boldsymbol{b}_{t,t+h} = \boldsymbol{0}$. The impulse responses to a period-t global risk shock are then given by the forecast $\boldsymbol{y}_{t,t+h}$ conditional on $\boldsymbol{\epsilon}_{t,t+h}$, with $\epsilon_t^r = 1$, $\epsilon_{t+s}^r = 0$ for $s > 0$ and $\epsilon_{t+s}^{\ell} = 0$ for $s \geq 0$, $\ell \neq r$.

In order to obtain the counterfactual conditional forecast $\widetilde{\boldsymbol{y}}_{t,t+h}$ SSA determines a series of additional shocks $\widetilde{\boldsymbol{\epsilon}}_{t,t+h}$ that materialize over periods $t, t+1, \dots, t+h$ and whose effects offset the dollar appreciation caused by the period-t global risk shock. This no-appreciation constraint can be written as $\widetilde{\boldsymbol{C}}\widetilde{\boldsymbol{y}}_{t,t+h} = \boldsymbol{0}$, where the $(h+1)\times n(h+1)$ matrix $\widetilde{\boldsymbol{C}}$ selects the conditional forecast of the dollar over periods $t, t+1, \dots, t+h$.[4] Constraints on the structural shocks are written as $\boldsymbol{\Xi}\widetilde{\boldsymbol{\epsilon}}_{t,t+h} = \boldsymbol{g}_{t,t+h}$, where the $k_s \times n(h+1)$ matrix $\boldsymbol{\Xi}$ first selects the period-t global risk shock and then any $k_s - 1$ structural shocks over periods $t, t+1, \dots, t+h$ that shall take on specific values to enforce the no-appreciation constraint.

ADPRR show how to obtain the SSA solution $\widetilde{\boldsymbol{\epsilon}}_{t,t+h}$ which satisfies the counterfactual no-appreciation constraint $\widetilde{\boldsymbol{C}}\widetilde{\boldsymbol{y}}_{t,t+h} = \boldsymbol{0}$ and the constraint on the set of structural shocks $\boldsymbol{\Xi}\widetilde{\boldsymbol{\epsilon}}_{t,t+h} = \boldsymbol{g}_{t,t+h}$. The solution implies the counterfactual impulse response $\widetilde{\boldsymbol{y}}_{t,t+h} = \boldsymbol{M}'\widetilde{\boldsymbol{\epsilon}}_{t,t+h}$.

In order to stay agnostic and let the data select the most likely offsetting shocks – see below for the intuition – we perform SSA without constraint on the set of structural shocks.[5] Incidentally, this also means we do not have to identify any additional structural shocks. This is because any orthogonal decomposition of the reduced-form shocks (i.e. any set of additionally identified structural shocks) that satisfies the exogeneity condition in Eq. (2) would produce the same result (Section 2.1 of ADPRR).

Because in every period $t, t+1, \dots, t+h$ we have up to $n > 1$ shocks to impose the no-appreciation constraint, there is a multiplicity of SSA solutions. ADPRR show that in this case the SSA solution minimizes the Frobenius norm of the deviation of $\widetilde{\boldsymbol{\epsilon}}_{t,t+h}$ from their baseline value of zero and diagonal variance matrix. This means the solution selects the smallest and least correlated shocks that enforce the no-appreciation constraint. We therefore interpret the SSA counterfactual as reflecting the most likely scenario in which the dollar does not appreciate following a global risk shock which could be observed in practice.

The first column in Fig. 4 shows the SSA counterfactual together with the baseline impulse responses. In response to a global risk shock the dollar does not appreciate by assumption, and both US and RoW real activity drop less than in the baseline; the reduction in the recessionary impact of the global risk shock amounts to up to 30%.[6]

The first column in Fig. 5 shows the SSA counterfactual together with the baseline impulse responses for variables reflecting the trade and financial channels. Two results stand out. First, consistent with the absence of expenditure switching, when the dollar does not appreciate US net exports drop by a little less. This suggests dollar appreciation is expansionary for the RoW in the baseline through the trade channel, although the latter is not very powerful. Second, while financial conditions still move in the counterfactual, they tighten by much less. This suggests dollar appreciation is contractionary through the financial channel in the baseline, and that the latter is rather powerful. Together with our findings for RoW activity, these results suggest the net effect of dollar appreciation upon a global risk shock is contractionary for the RoW and that the financial channel dominates the trade channel.[7]

The SSA counterfactual is conceptually appealing because it uses those offsetting shocks which are most likely to materialize in practice and is otherwise agnostic about the nature of these shocks. Yet for this very reason it is not possible to tell why the dollar does not appreciate in the counterfactual. In what follows, we therefore complement the SSA counterfactual with two alternatives that allow a structural interpretation. The first alternative counterfactual we consider has a concrete economic interpretation as a monetary-policy-rule counterfactual. In particular, we next explore how a global risk shock would affect the RoW if the Fed were to stabilize the dollar.

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[4] Ordering the dollar last in $\boldsymbol{y}_t$, we have $\widetilde{\boldsymbol{C}} = \boldsymbol{I}_{h+1} \otimes \boldsymbol{e}_n'$, where $\boldsymbol{e}_i$ is $n\times 1$-vector of zeros with unity at the ith position.

[5] Ordering the global risk shock last in $\boldsymbol{\epsilon}_t$, we have $\boldsymbol{g}_{t,t+h} = 1$ and $\boldsymbol{\Xi} = [\boldsymbol{e}_n', \boldsymbol{0}_{1\times hn}]$, where $\boldsymbol{e}_i$ is an $n\times 1$ vector of zeros with unity at the ith position.

[6] In Figure B.11 in the Online Appendix we show that about 90% of the posterior probability mass of the difference between the baseline and the counterfactual is larger than zero.

[7] We report the counterfactual impulse responses for the remaining variables in the BPSVAR model in the Online Appendix (Figure B.13).

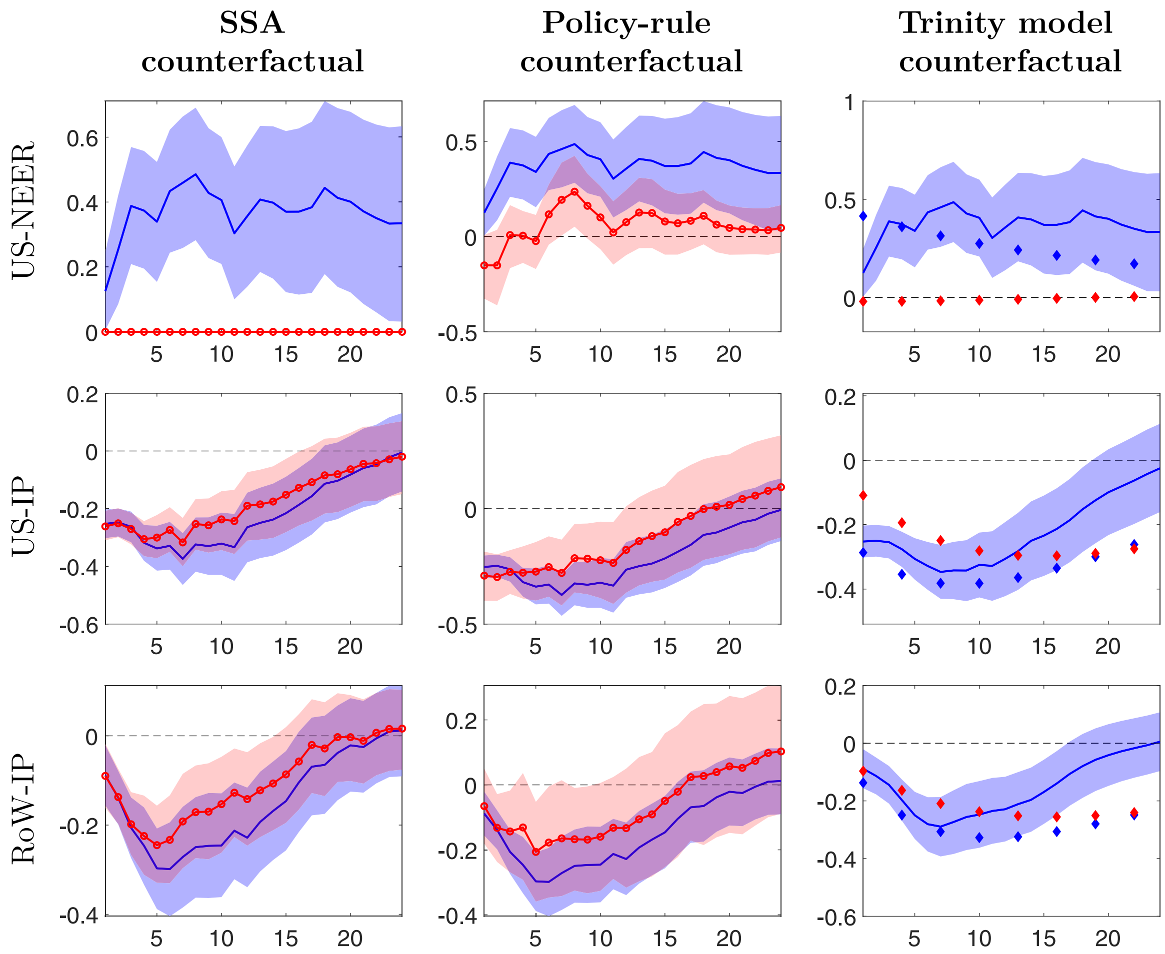

Fig. 4. Baseline and counterfactual responses to a global risk shock.
Note: The figure shows the baseline BPSVAR model (blue solid) and counterfactual (red circled) impulse responses to a global risk shock. SSA counterfactuals are shown in the first column, policy-rule counterfactuals in the second column, and the trinity-model counterfactuals in the third column. The red (blue) shaded areas represent 68% credible sets obtained from computing the counterfactual (impulse responses) for each draw from the posterior distribution. In the third column, the blue (red) diamonds depict the baseline (counterfactual) impulse responses to a global risk aversion shock in the trinity model. We do not connect the dots depicting the counterfactual because the trinity model is calibrated to quarterly frequency while the BPSVAR model is estimated at the monthly frequency. The global risk aversion shock in the trinity model is scaled such that the average of the response of the dollar over the first year is the same as the response from the BPSVAR model. The real GDP (output) response in the trinity model is multiplied by 2.5 to make it comparable to the industrial production response from the BPSVAR model given that in the data the latter is 2.5 times more volatile than the former. In the Online Appendix we document that the BPSVAR model impulse response of S&P Global's US monthly GDP is indeed about 2.5 times smaller than for US industrial production (Figure B.12), while their time profiles are rather similar.

4.2. *What if the Fed stabilized the dollar?*

Standard uncovered interest rate parity (UIP) logic suggests the Fed could prevent dollar appreciation upon a global risk shock by loosening more than in the baseline. One would then expect the additional Fed loosening to be expansionary for the RoW and hence mitigate the contractionary effects of the global risk shock. We next consider a policy-rule counterfactual in the BPSVAR model to explore this rigorously.

VAR-based policy counterfactuals using structural shocks have a long history in the literature (e.g. Sims and Zha, 2006). Typically, these counterfactuals are constructed in an SSA-like fashion with unexpected policy shocks materializing every period along the entire impulse-response horizon $t, t+1, \ldots, t+h$. These counterfactuals are often conceived as a change in the policy rule (for example Kilian and Lewis, 2011). However, this approach may be subject to the Lucas critique and in general does not recover the true policy-rule counterfactual McKay and Wolf (2023, henceforth MW). Intuitively, this is because it is assumed that although agents are being repeatedly surprised they do not adjust their expectations about future policy behavior. Put differently, this approach ignores a possible expectations channel through which a policy-rule change may impact the economy.

MW develop an approach for constructing policy-rule counterfactuals in VAR models that is robust to the Lucas critique and recovers the true policy-rule counterfactual for a broad range of underlying structural frameworks, including standard representative

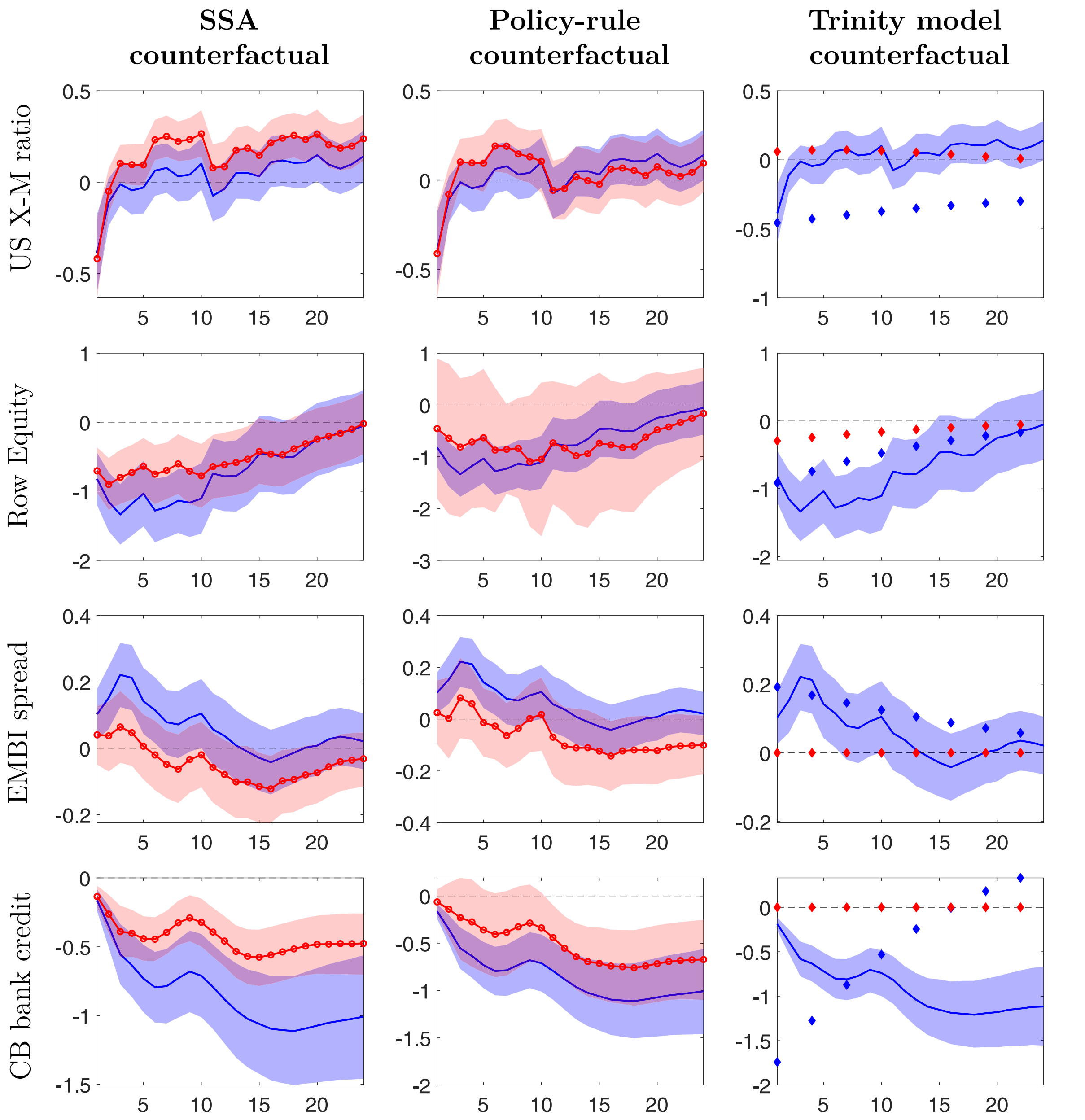

Fig. 5. Baseline and counterfactual responses of trade and financial variables to a global risk shock.
Note: See notes to Fig. 4. As the trinity model does not include an exact match for equity prices (the EMBI spread) we plot the response of the price of capital (RoW cross-border credit spread) instead. In the counterfactual structural model dollar dominance is absent so that standard UIP holds. Therefore any exchange-rate-adjusted cross-border border return differential is zero.

and heterogeneous-agent New Keynesian models. In particular, they show that using appropriate impact-period-t *news* shocks about current and future policy recovers the impulse responses that would prevail under a counterfactual policy rule. Put differently, MW show that using appropriate period-t policy news shocks is an equivalent approach to explicitly simulating a shock under a counterfactual policy rule.

Formally, motivated by the representation of structural models in sequence space introduced by Auclert et al. (2021), MW consider a linear, perfect-foresight, infinite-horizon economy in terms of deviations from the deterministic steady state for periods $t = 0, 1, 2, \ldots$ summarized by

$$\mathcal{H}_x \boldsymbol{x} + \mathcal{H}_z \boldsymbol{z} + \mathcal{H}_\epsilon \boldsymbol{\epsilon} = \boldsymbol{0}, \tag{4}$$

$$\mathcal{A}_x \boldsymbol{x} + \mathcal{A}_z \boldsymbol{z} + \boldsymbol{\nu} = \boldsymbol{0}, \tag{5}$$

where $\boldsymbol{x} \equiv (\boldsymbol{x}_1', \boldsymbol{x}_2', \ldots, \boldsymbol{x}_{n_x}')'$ stacks the time paths of the n_x endogenous variables, analogously $\boldsymbol{z}$ the n_z policy instruments, $\boldsymbol{\epsilon}$ the n_ϵ non-policy structural shocks and $\boldsymbol{\nu}$ the n_ν policy news shocks; the latter are deviations from the policy rule announced at date t but implemented only in some future period $t+s$, $s>0$. The key assumption reflected in Eqs. (4) and (5) is that $\{\mathcal{H}_x, \mathcal{H}_z, \mathcal{H}_\epsilon\}$ do not depend on the coefficients of the policy rule $\{\mathcal{A}_x, \mathcal{A}_z\}$, so that policy affects the private sector's decisions only through the path of the instrument $\boldsymbol{z}$, rather than through the policy rule *per se*. Under some mild assumptions the solution to Eqs. (4) and (5) can be written using impulse response coefficients $\boldsymbol{\Theta}_{\mathcal{A}}$ as

$$\begin{pmatrix} \boldsymbol{x} \\ \boldsymbol{z} \end{pmatrix} = \boldsymbol{\Theta}_{\mathcal{A}} \times \begin{pmatrix} \boldsymbol{\epsilon} \\ \boldsymbol{\nu} \end{pmatrix}, \quad \boldsymbol{\Theta}_{\mathcal{A}} \equiv \left(\boldsymbol{\Theta}_{\epsilon,\mathcal{A}}, \boldsymbol{\Theta}_{\nu,\mathcal{A}}\right) \equiv \begin{pmatrix} \boldsymbol{\Theta}_{x,\epsilon,\mathcal{A}} & \boldsymbol{\Theta}_{x,\nu,\mathcal{A}} \\ \boldsymbol{\Theta}_{z,\epsilon,\mathcal{A}} & \boldsymbol{\Theta}_{z,\nu,\mathcal{A}} \end{pmatrix}. \tag{6}$$

MW show that knowledge of the impulse responses $\boldsymbol{\Theta}_{\mathcal{A}}$ under the baseline policy rule is sufficient to determine the impulse responses to the structural shock ϵ under any counterfactual policy rule $\tilde{\mathcal{A}}_x \boldsymbol{x} + \tilde{\mathcal{A}}_z \boldsymbol{z} = \boldsymbol{0}$ as

$$\boldsymbol{x}_{\tilde{\mathcal{A}}}(\epsilon) = \boldsymbol{x}_{\mathcal{A}}(\epsilon) + \boldsymbol{\Theta}_{x,\nu,\mathcal{A}} \times \tilde{\boldsymbol{\nu}}, \qquad \boldsymbol{z}_{\tilde{\mathcal{A}}}(\epsilon) = \boldsymbol{z}_{\mathcal{A}}(\epsilon) + \boldsymbol{\Theta}_{z,\nu,\mathcal{A}} \times \tilde{\boldsymbol{\nu}}. \tag{7}$$

In particular, the impulse response to the structural shock ϵ under the counterfactual policy rule is given by the sum of the corresponding impulse responses to the same structural shock under the baseline policy rule $\boldsymbol{x}_{\mathcal{A}}(\epsilon)$ and the impulse responses to some policy news shocks $\tilde{\boldsymbol{\nu}}$. The latter are chosen so that the counterfactual policy rule

$$\tilde{\mathcal{A}}_x \left[\boldsymbol{x}_{\mathcal{A}}(\epsilon) + \boldsymbol{\Theta}_{x,\nu,\mathcal{A}} \times \tilde{\boldsymbol{\nu}}\right] + \tilde{\mathcal{A}}_z \left[\boldsymbol{z}_{\mathcal{A}}(\epsilon) + \boldsymbol{\Theta}_{z,\nu,\mathcal{A}} \times \tilde{\boldsymbol{\nu}}\right] = \boldsymbol{0} \tag{8}$$

holds. The intuition is that as long as the private sector's decisions depend on the path of the policy instrument rather than the rule *per se* it does not matter whether the path comes about due to the systematic conduct of policy or due to policy news shocks.

A practical challenge of this approach is that news shocks $\tilde{\nu}$ which communicate changes in future policy over all possible horizons $t, t+1, t+2, \ldots$ are rarely available to the econometrician. However, MW show that in practice one can use a set of standard monetary policy shocks $\boldsymbol{s}$ and their impulse responses $\boldsymbol{\Omega}_{s,\mathcal{A}}$ from the empirical literature as long as each entails a different future path of the policy instrument. Moreover, MW show that rather than requiring impulse responses to as many shocks as horizons over which the counterfactual policy-rule is assumed, using even only a small number of shocks $\boldsymbol{s}$ that solve

$$\min_{\boldsymbol{s}} \ \| \tilde{\mathcal{A}}_x \left[\boldsymbol{x}_{\mathcal{A}}(\epsilon) + \boldsymbol{\Omega}_{x,s,\mathcal{A}} \times \boldsymbol{s}\right] + \tilde{\mathcal{A}}_z \left[\boldsymbol{z}_{\mathcal{A}}(\epsilon) + \boldsymbol{\Omega}_{z,s,\mathcal{A}} \times \boldsymbol{s}\right] \|, \tag{9}$$

produces a reliable "best Lucas-critique-robust approximation".

Against this background, we explore how a global risk shock would affect the RoW if the Fed were to stabilize the dollar. As in Wolf (2023), we specify the counterfactual policy rule implicitly as $\boldsymbol{e}_{usd}\boldsymbol{x} = \boldsymbol{0}$, where $\boldsymbol{e}_{usd}$ is a $1 \times n_x$-vector of zeros with unity at the position of the dollar in $\boldsymbol{x}_t$. Confining the counterfactual to periods $t = 0, 1, 2, \ldots, h$, Eq. (9) becomes

$$\min_{\boldsymbol{s}} \ \| \boldsymbol{e}_{usd}\boldsymbol{x}_{\mathcal{A},t,t+h}(\epsilon) + \boldsymbol{\Omega}_{x,s,\mathcal{A}} \times \boldsymbol{s} \|, \tag{10}$$

which boils down to solving a least-squares minimization problem for n_s unknown period-t Fed policy shocks $\boldsymbol{s}$ in $h+1$ equations.

We implement this policy-rule counterfactual using $n_s = 2$ distinct US monetary policy shocks, just like MW do in their illustration. In particular, in addition to the global risk shock we jointly identify a conventional monetary policy and a forward guidance shock using similar proxy variables as Miranda-Agrippino and Rey (2020a) and Miranda-Agrippino and Nenova (2022), namely intra-daily surprises in the 3-month Federal funds futures and the 5-year Treasury bill rate in a narrow window around FOMC announcements as proxy variables.[8]

We estimate that a contractionary conventional monetary policy shock raises interest rates at relatively shorter horizons, as given by the 1-year Treasury bill rate (Figure B.14). In turn, we estimate that a contractionary forward guidance shock raises interest rates at relatively longer horizons, as given 5-year Treasury bill rate (Figure B.15). Both shocks slow down real activity in the US and the RoW, tighten global financial conditions, and appreciate the dollar.[9,10] To implement the policy-rule counterfactual we let both a conventional and a forward guidance Fed policy shock occur in period t together with the global risk shock, and choose their size so that they offset as much as possible – in a least squares sense – the response of the dollar.

[8] This means that in Eq. (1) the structural shocks of interest are given by $\epsilon_t^* \equiv (\epsilon_t^r, \epsilon_t^{cmp}, \epsilon_t^{fg})'$, where ϵ_t^{cmp} and ϵ_t^{fg} denote the conventional monetary policy and forward guidance shocks, respectively, and the corresponding proxy variables are given by $\boldsymbol{p}_t \equiv (p_t^{\epsilon,r}, p_t^{\epsilon,3m}, p_t^{\epsilon,5y})'$. In Eq. (2) we impose the additional identifying assumptions that the 3-month and 5-year-rate surprises are not driven by the global risk shock, $E[p_t^{\epsilon,3m}\epsilon_t^r] = E[p_t^{\epsilon,5y}\epsilon_t^r] = 0$ (Gertler and Karadi, 2015; Miranda-Agrippino and Rey, 2020b). Note that these assumptions imply two zeros in the first column of $\boldsymbol{V}$ in Eq. (2), which are sufficient to point-identify the global risk shock. It would be intuitive to go further and impose that $\boldsymbol{V}$ is diagonal to disentangle the conventional monetary policy and forward guidance shocks, but this would imply over-identifying restrictions that cannot be imposed in the estimation algorithm of Arias et al. (2021). To nonetheless disentangle the two monetary policy shocks we instead impose magnitude restrictions. In particular, we assume that the 3-month-rate (5-year-rate) surprise is affected more strongly by the conventional monetary policy (forward guidance) shock than by the forward guidance (conventional monetary policy) shock, that is $E[p_t^{\epsilon,3m}\epsilon_t^{cmp}] > E[p_t^{\epsilon,3m}\epsilon_t^{fg}]$ and $E[p_t^{\epsilon,5y}\epsilon_t^{fg}] > E[p_t^{\epsilon,5y}\epsilon_t^{cmp}]$.

[9] Because we only have data on the 5-year-rate surprises from 1996, as in Känzig (2021) we set the missing values in the 3-month Federal funds futures and the 5-year Treasury bill rate surprises to zero (see Noh, 2017, for a formal justification of this approach). However, Figures B.16 and B.17 in the Online Appendix document that our results are robust to starting the estimation only in 1996. We follow Miranda-Agrippino and Nenova (2022) and apply the poor-man's approach of Jarociński and Karadi (2020) and purge these surprises from central bank information effects on the basis of the sign of the corresponding equity-price surprise.

[10] We document that results are similar if instead of the 3-month and 5-year-rate surprises we use as proxy variables the conventional monetary policy and forward guidance surprises of Jarociński (2021) or Lewis (2024), which both also account for central bank information effects (Figures B.18 to B.21).

The middle columns in Figs. 4 and 5 present the results for this policy-rule counterfactual. Despite the conceptual difference, the results of this policy-rule counterfactual are quite similar to those of the SSA counterfactual.[11] In the Online Appendix we show that a non-trivial additional Fed easing in terms of the 1 and 5-year Treasury bill rates is required to stabilize the dollar (Figure B.23) and that at the posterior mean the required policy shocks are both expansionary and equal about half of their standard deviation (Figure B.24).

4.3. A world economy without structural dollar dominance

The VAR-based counterfactuals take the non-policy structure of the world economy as given and explore what would happen if offsetting shocks materialized or if the Fed were to stabilize the dollar. Although the latter provides a well-defined structural explanation for the absence of appreciation, it explicitly leverages changes in policy and thereby intertwines the effect of the dollar appreciation with the change in the policy rate. Therefore, as an alternative, one may consider changing the non-policy structural features of the world economy that underpin the dollar's response to a global risk shock in the first place. Hence, in what follows we construct a third counterfactual based on a structural two-country model for the US and the RoW. The model matches the empirical impulses responses in Fig. 2 and allows us to modify the non-policy structural features so that the dollar does not appreciate upon a global risk shock.

We draw on the two-country model for the US and the RoW with dollar dominance in cross-border credit, safe assets and trade invoicing developed in Georgiadis et al. (2023). Laying out the structure of this 'trinity model' is beyond the scope of this paper, and so we only provide an intuitive description.[12] In the model, US banks intermediate domestic dollar funds to banks in the RoW. Cross-border dollar borrowing is cheap but also risky relative to domestic funding, and therefore tightens RoW banks' balance-sheet constraints. Because they are viewed as the global safe asset, US Treasuries are held as liquidity-buffers by RoW banks to loosen balance-sheet constraints and thereby earn an additional, indirect pecuniary return that we interpret as a convenience yield.

In the trinity model dollar dominance in cross-border credit and safe assets interact so that the dollar appreciates in response to a global risk shock. In particular, an increase in global risk aversion – modeled as an exogenous reduction in the willingness of creditors to provide funding to banks for a given balance-sheet size and composition – raises domestic credit spreads so that leveraging up by loosening the balance-sheet constraint becomes more profitable, which increases the indirect return of holding Treasuries in terms of the convenience yield, which causes the dollar to appreciate. In turn, this dollar appreciation triggers a global financial accelerator. In particular, as RoW banks' cross-border dollar borrowing is not perfectly hedged by holdings of Treasuries, dollar appreciation reduces their net worth. As a result, the balance-sheet constraint of US banks lending to RoW banks tightens and forces them to deleverage, which raises US and RoW domestic credit spreads further.

Fig. 6 summarizes the mechanics of this global financial accelerator and highlights how dollar dominance in safe assets and cross-border credit interact to give rise to dollar appreciation when risk aversion rises: Dollar dominance in safe assets underpins a dollar appreciation when global risk aversion rises, and dollar dominance in cross-border credit a global financial accelerator when the dollar appreciates.[13]

The right-hand side columns in Figs. 4 and 5 show that the impulse responses to a global risk aversion shock for the baseline calibration of the trinity model (blue dots) match the BPSVAR model impulse responses (blue solid lines) fairly well.[14]

For the counterfactual we assume the dollar does not hold any dominant position in the world economy: There is no cross-border dollar credit and RoW banks do not demand Treasuries as safe asset. The counterfactual impulse responses (red dots) show that without dollar dominance the dollar does not appreciate when global investors' risk aversion increases (Fig. 4), that global financial conditions in terms of equity valuations, spreads and cross-border credit tighten by less (Fig. 5), and that output drops by less both in the US and the RoW (Fig. 4). The reason is that without dollar dominance in safe assets, holding Treasuries no longer loosens balance-sheet constraints of RoW banks and hence does not earn a convenience yield. As a result, the dollar does not appreciate when global investors' risk aversion increases. And without dollar appreciation and dollar dominance in cross-border credit there is no global financial accelerator mechanism that amplifies the effect of a global risk aversion shock on the RoW. Finally, US net exports fall by less – in fact rise – in the absence of dollar dominance.[15]

Taken together, the results of the trinity-model counterfactual is consistent with those of the SSA and the policy-rule counterfactuals. We consistently find that the contractionary financial channel dominates the expansionary trade channel. The net effect of dollar appreciation upon a global risk shock is contractionary for the RoW.

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[11] The dollar is not perfectly stabilized because we use only $n_s = 2$ rather than $h+1$ policy shocks in Eq. (10). However, our results are similar if we use a third US monetary policy shock (i.e. $n_s = 3$) identified by 10-year Treasury bill rate surprises as proxy variable so that the dollar is more stable upon a global risk shock (Figure B.22). Moreover, in the Online Appendix F we document that using the structural model we discuss in Section 4.3 below as a laboratory, the true policy-rule counterfactual is approximated fairly well with the approach of MW and only two distinct policy (news) shocks (Figure F.4).

[12] We provide a detailed discussion of the model, all equations and the calibration in Online Appendix D.

[13] There is an additional amplification channel shown in the middle of Fig. 6 that arises because also cross-border credit spreads rise as US banks' balance-sheet constraints tighten, which reduces RoW banks' net worth independently from the dollar appreciation.

[14] In order to make percentage deviations of flow variables – such as output – from the quarterly business-cycle model comparable to those from the monthly BPSVAR model we report the three-month trailing moving average of the latter's impulse responses as suggested by Born and Pfeifer (2014).

[15] In the Online Appendix we document that results are similar in a trinity-model policy-rule counterfactual in which the Fed stabilizes the dollar exchange rate rather than US output and inflation (Figures F.1 to F.3).

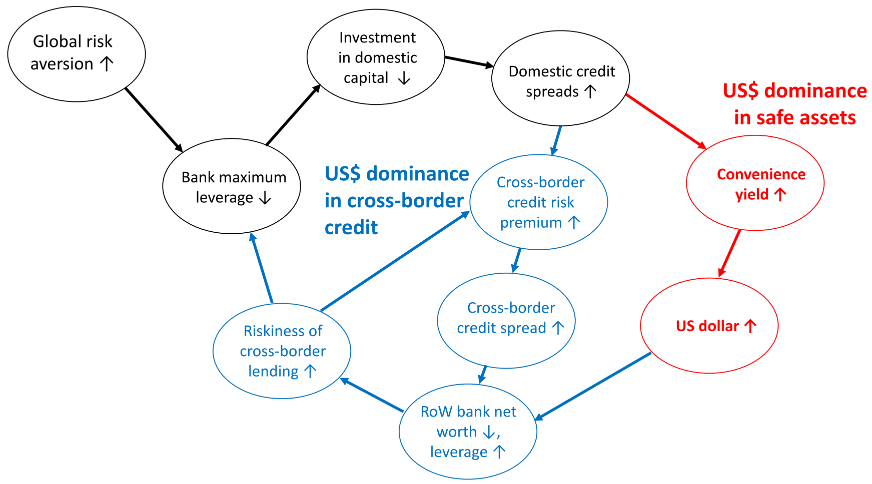

Fig. 6. The global financial accelerator in the trinity model of Georgiadis et al. (2023).
Note: The figure presents a schematic overview of the global financial accelerator in the trinity model of Georgiadis et al. (2023).

5. Conclusion

In this paper we provide evidence that global risk shocks cause a dollar appreciation and a slowdown in world real activity. In order to shed light on the dollar's role in the international transmission of global risk, we construct three conceptually distinct no-appreciation counterfactuals. The results suggest robustly that without dollar appreciation the slowdown in global economic activity would be much weaker. This raises important normative questions about the design of the international financial architecture that underpin the key role of the dollar in the global economy. These are, however, beyond the scope of the present paper.

Data availability

Data will be made available on request.

Appendix A. Supplementary data

Supplementary material related to this article can be found online at https://doi.org/10.1016/j.jmoneco.2024.01.002.

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